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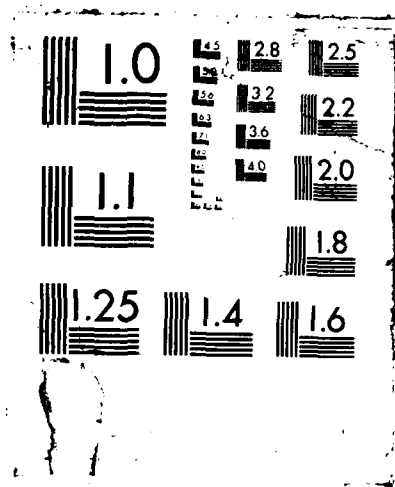
DEVELOPMENT OF AN OPTICAL FEEDBACK BASED HIGH ACCURACY 1/1
BEAM TRANSMISSOMETER(U) SEA TECH INC CORVALLIS OR
R BARTZ 25 NOV 87 N00014-86-C-0784

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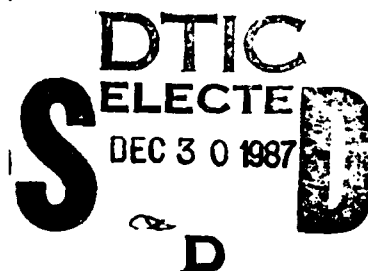
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FINAL REPORT
TO
OFFICE OF NAVAL RESEARCH

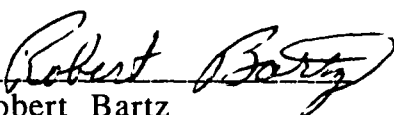


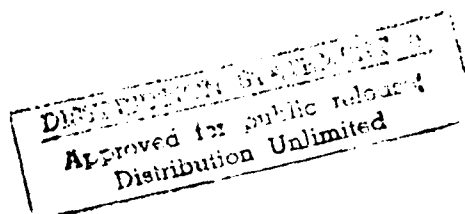
CONTRACT NO: N00014-86-C-0784

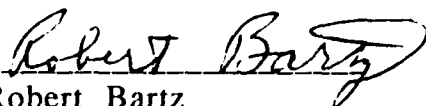
TITLE: Development of an Optical Feedback Based
High Accuracy Beam Transmissometer

ITEM NO: 0001AC

DATE: 25 NOVEMBER 1987


Robert Bartz
Principal Investigator




Robert Bartz
President

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FINAL REPORT: Development of an Optical Feedback Based High Accuracy Beam Transmissometer

Sea Tech Inc.

Contract No. N00014-86-C-0784

Item No. 0001AC, 87NOV25

INTRODUCTION

The Phase I research has addressed the need for spectral light transmission data. Over the years the oceanographic community has repeatedly asked for a transmissometer operating at other wavelengths, specifically blue and green. The existing Sea Tech transmissometer is only available with a red LED, (light emitting diode) light source, mainly because LED's at shorter wavelengths have much lower power output. The primary objective of Phase I research was to determine if the transmissometer could be redesigned using LED's of other wavelengths. Constraints imposed on the new design was to achieve the same high performance inherent in the existing red transmissometer that has served the oceanic community so well for over 10 years.

During the research performed in Phase I of this project a methodology and technique has been successfully developed for the stabilization of low power LED light sources to be used in the transmissometer. During the Phase I research, both red and blue LED's were evaluated in a optical bridge configuration allowing stabilization of the LED's using optical feedback. The LED's were installed in a collimator having a spatial filter 0.25 mm in diameter and a lens with a focal length of 60 mm resulting in a collimation angle of 4.16 milliradians in air. This same high degree of collimation is used in the existing Sea Tech red transmissometer.

Recently Sea Tech acquired samples of the Panasonic blue LED and decided to evaluate these devices in a conventional optical bridge in lieu of the proposed integrated package that would have limited testing to only the red wavelength, (the blue LED chip's could not be obtained). The blue LED represents worst case with respect to power output. Worst case because the blue LED has lower power output when compared to green and red LED's. Also, spectral line width for the blue LED was too broad and had to be filtered which resulted in a further decrease in power output.

The results of this evaluation are very encouraging, (see test results) and show that building a transmissometer with the lowest power LED is now possible. The extension of this work, about which the Phase II proposal is based, is to implement a

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wide range of light sources into the Sea Tech transmissometer and use the optical bridge technique to stabilize them as well. Blue, green, yellow and orange LED'S can now be used in the transmissometer but are inherently much less stable than the red sources. Consequently, the research proposed for Phase II will address research related to the design and implementation of transmissometers using these light sources. Working in conjunction with the Optical Oceanography Group at Oregon State University, overall performance of the instrument and its inherent limitations will be evaluated. The results of this work will be published providing the scientific community with a basis for correctly interpreting the transmissometer data.

RESEARCH RESULTS

Progress reports, 1 and 2 listed the results of component evaluation and circuit design needed to implement the optical bridge. This report will focus on the overall performance of the optical bridge using a blue LED. Additional effort has been expended to improve the integrated optical bridge design and this new design will be implemented during Phase 2. This new design is now feasible as will be shown below.

Modification of the blue LED to evaluate its performance was necessary, (see figure 1). The front surface of the LED package was machined and polished to enable location of the light emitting area close to the spatial filter. The LED and spatial filter was assembled as shown in figure 2. This light source assembly was then installed in the collimator, figure 3, which is equipped with an interference filter. This interference filter has a full band width of 50 nm as shown in figure 4. This filtered and collimated light source was then installed on the optical bridge as shown in figure 5. Connections were then made to the circuitry shown in figure 6 & 7 and component values selected to obtain desired outputs.

Test results for the blue LED are as follows: Minimum detectable signal is 0.02% and stability was $\pm 0.05\%$ over a 24 hour period, (see figure 8). Power consumption is approximately 200 milliwatts and can be reduced considerably during phase 2 with the more efficient Siemens blue LED. The temperature stability of the blue optical bridge was not evaluated and will be addressed during Phase 2. Detectors used in the optical bridge were tested using a red, 670 nm LED. Temperature stability of six detectors were measured over 0-25° C. The detectors response changed less than 0.2% over this temperature range.

Problems encountered during the testing phase were with the temperature instability of the electronics. Since the main objective was to evaluate the performance of the optical bridge using the low power blue LED, the electronics were maintained at

ambient temperature to permit accurate measurements. The problems with temperature instability of all components will be addressed during Phase 2.

Considerable effort has been made to acquire a blue LED in chip form to integrate the optical bridge in a small TO-5 package. Progress to date is an agreement by Siemens to provide Sea Tech the blue LED in chip form by 12/1/87. This device is still in the development stage at the Siemens plant in Germany. This chip will be used to build the light source designed recently and shown in Figure 10. The new design uses a detector with a hole in the center which will perform two functions, one it will monitor power output and two, it will spatially filter the beam which is necessary to achieve good collimation. EG&G will develop the special detector with a hole in the center with Phase 2 funding and will fabricate the integrated package. The interference filter shown in the new design will be provided by Spectro Film. The spectral characteristics of the new package using the Siemens blue LED is shown in figure 9. It should be pointed out here that this same design can be used to implement other wavelengths and during Phase 2 at least blue, green, and red will be evaluated.

CONCLUSIONS

Research performed during Phase 1 has provided a solid base from which Phase 2 can proceed. The most significant development was to successfully incorporate the blue LED in an optical bridge design. This has been done with the same high degree of collimation, < 5 milliradians as used in the standard Sea Tech transmissometers. Adequate signal to noise ratio shows that the new optical bridge integrated design is feasible when the lowest power LED's are used.

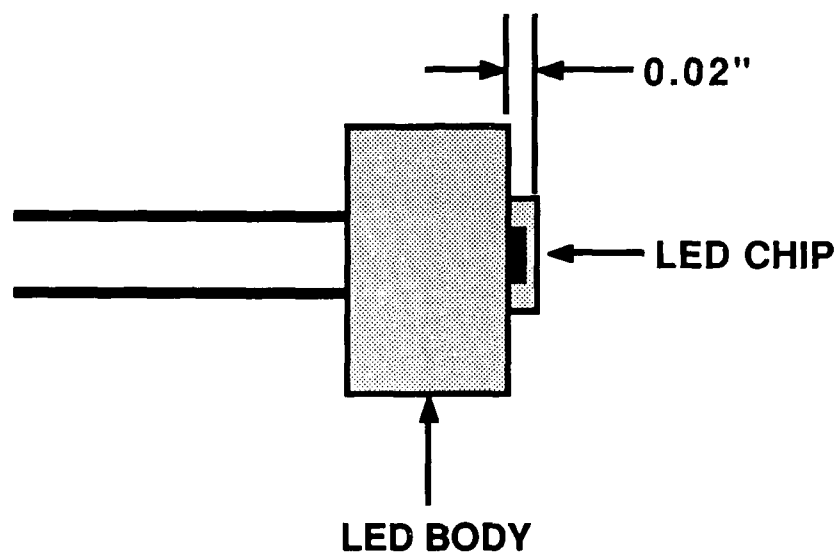


FIGURE 1, MODIFIED BLUE LED

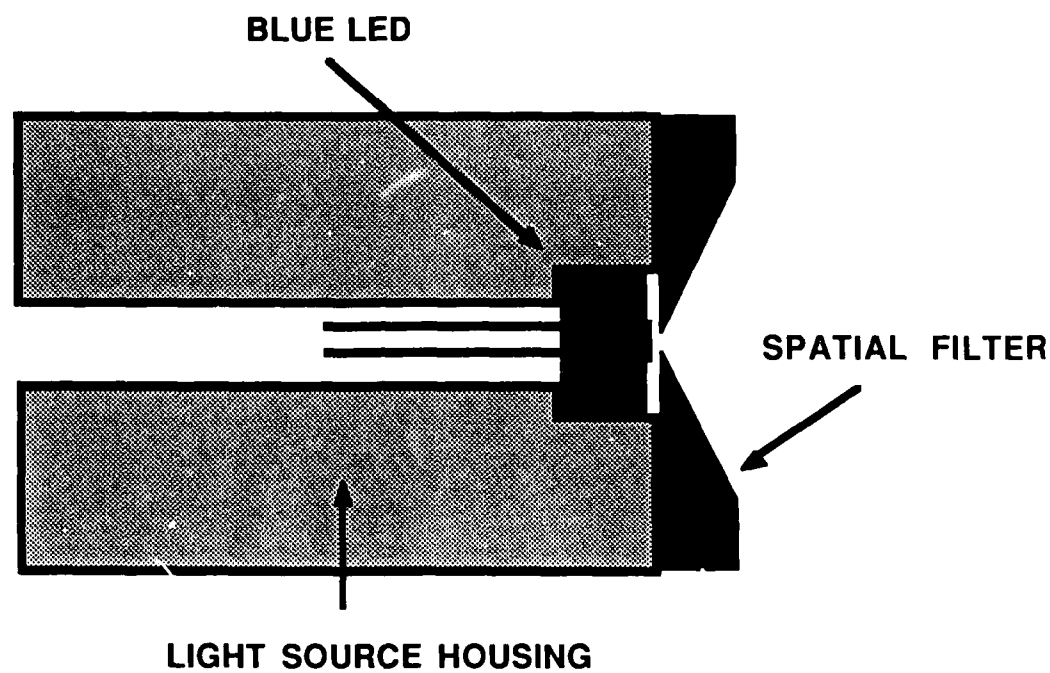


FIGURE 2, BLUE LIGHT SOURCE ASSEMBLY

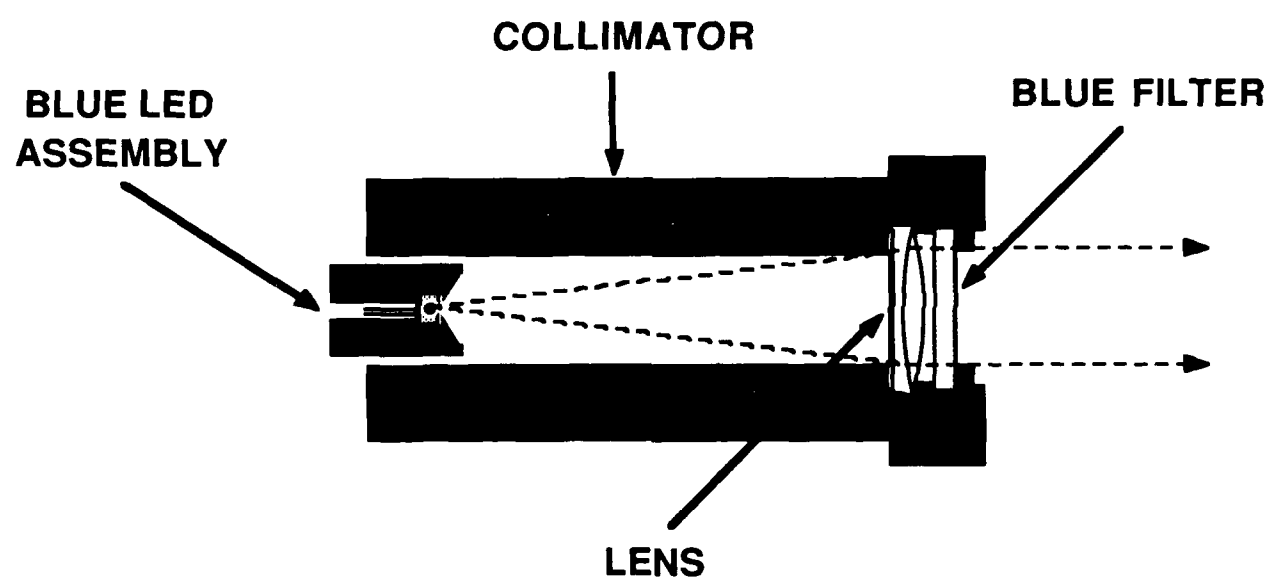


FIGURE 3, COLLIMATOR DESIGN

Blue Filter 103187

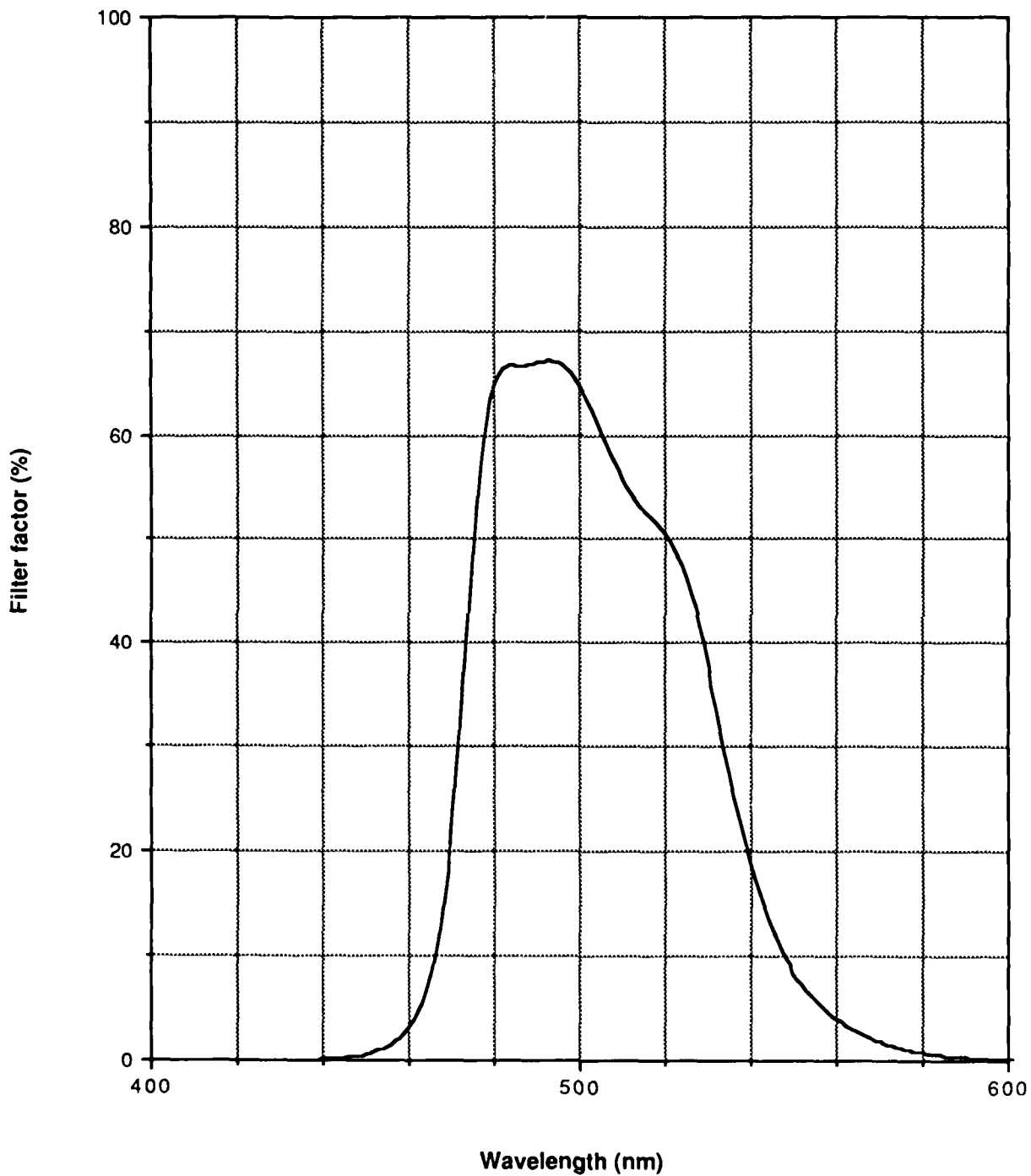


Figure 4

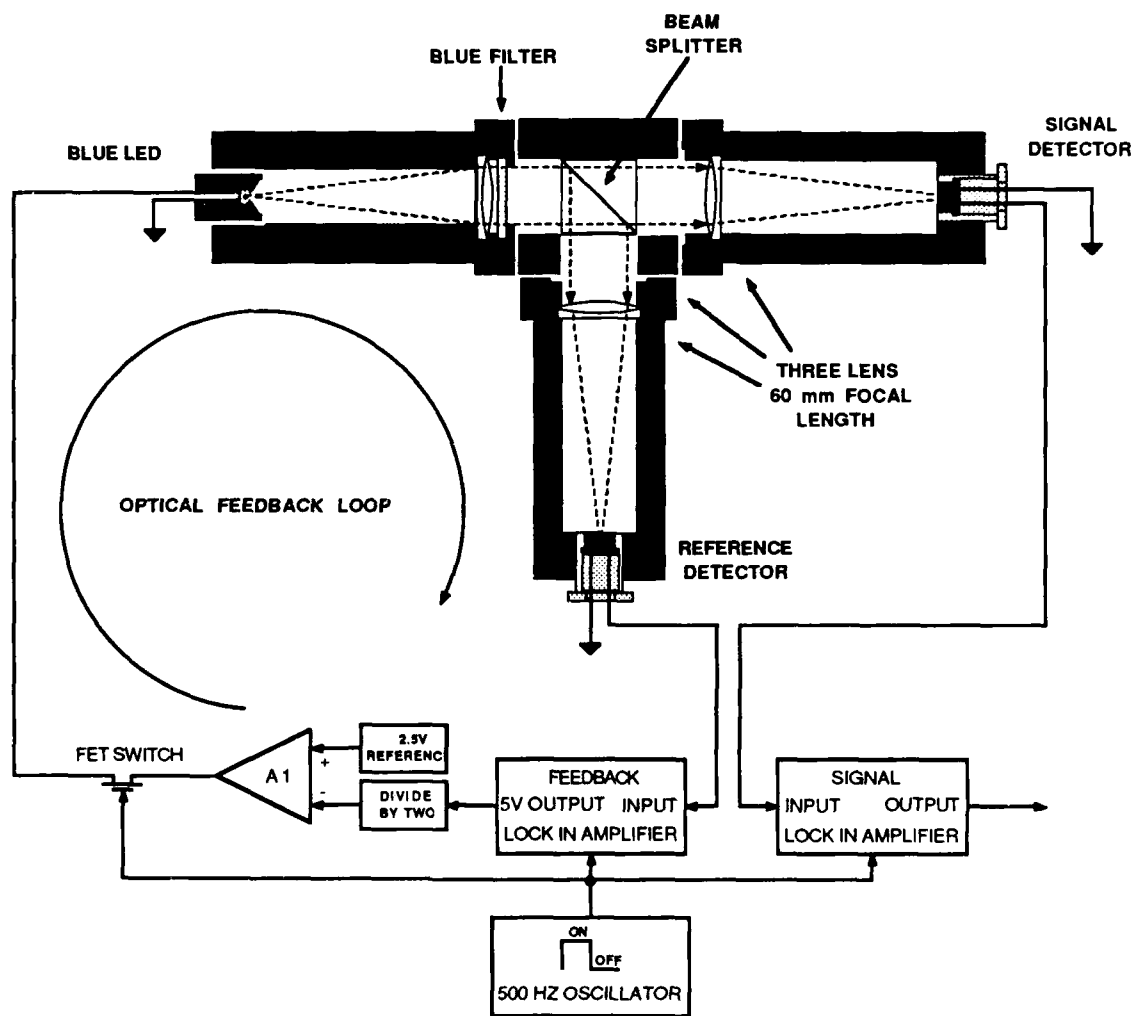
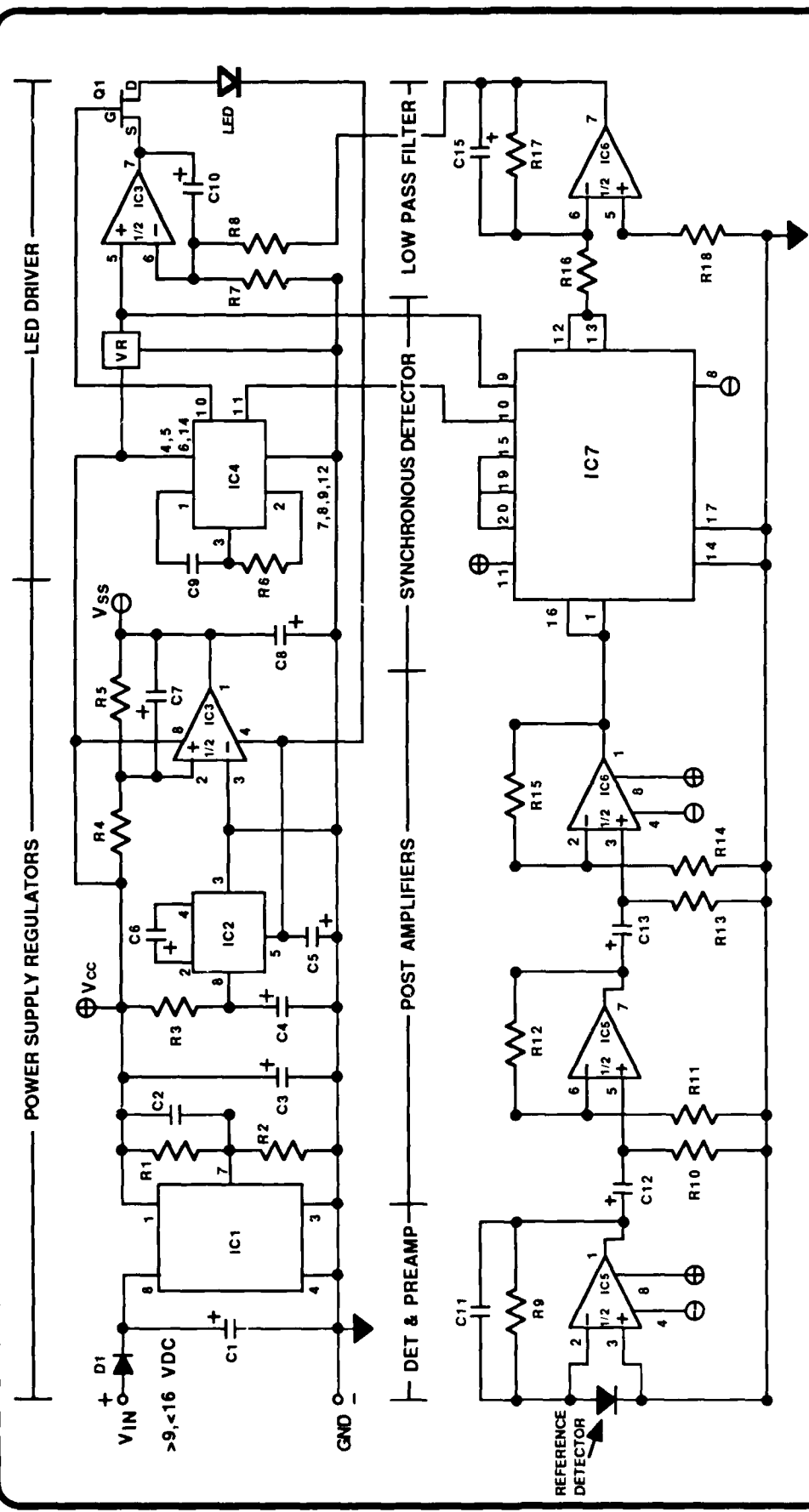
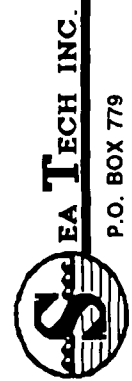


FIGURE 5, OPTICAL BRIDGE TEST SET UP

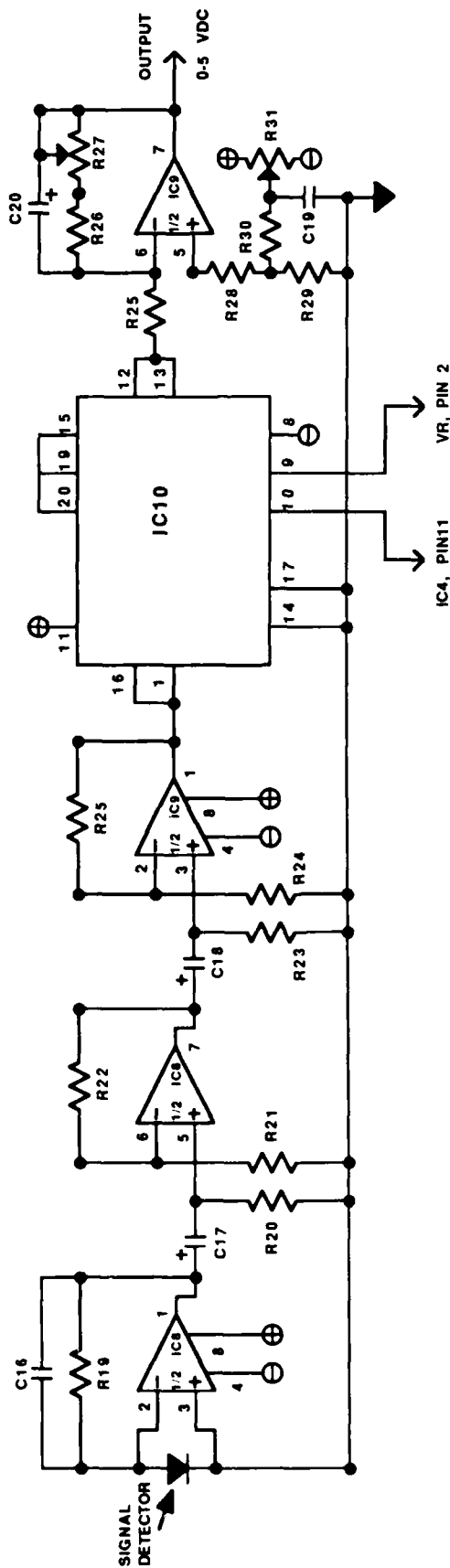


NOTES

Figure 6



— DET & PREAMP — POST AMPLIFIERS — SYNCHRONOUS DETECTOR — LOW PASS FILTER —



NOTES

Figure 7



EA TECH INC.
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O/B TRANSMISSOMETER RECEIVER SCHEMATIC

FILE: FIGURE 7, O/B PHASE 1 FINAL REPORT

BOB BARTZ

10/25/87

Blue Stability Test

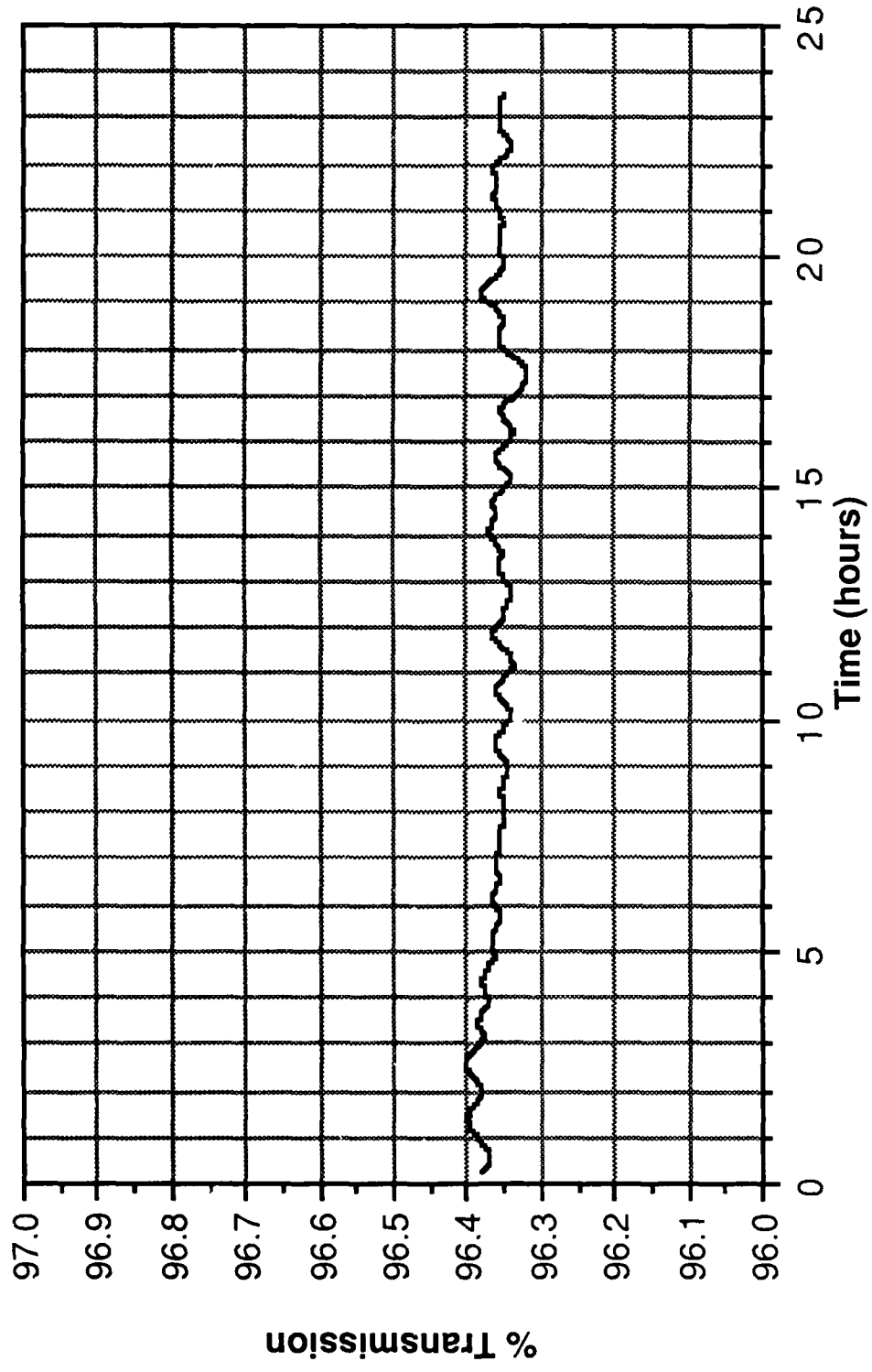
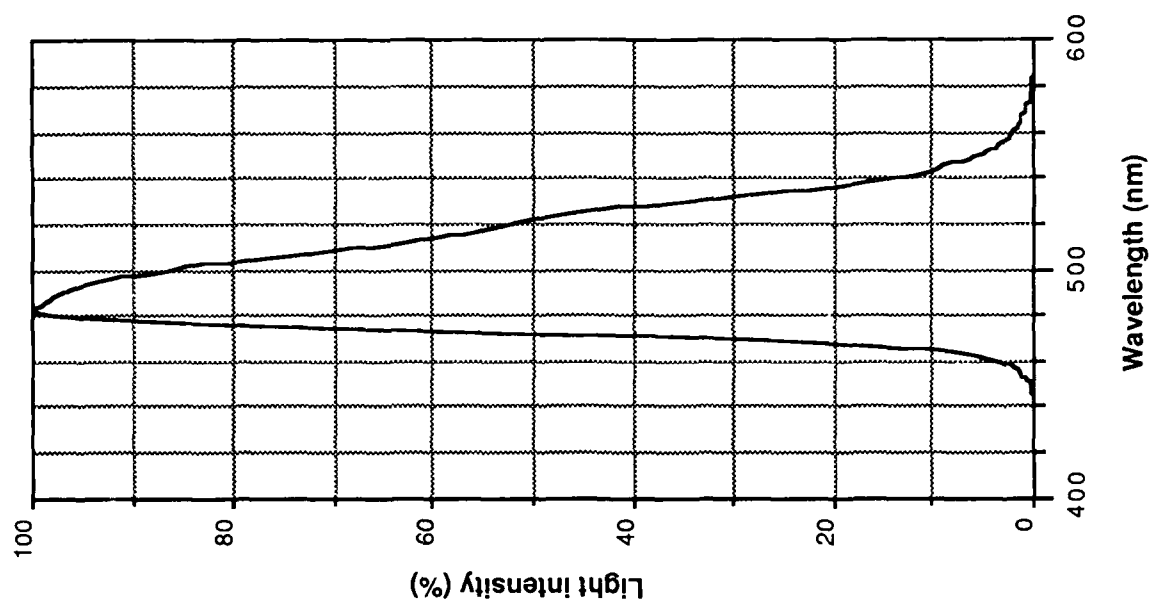
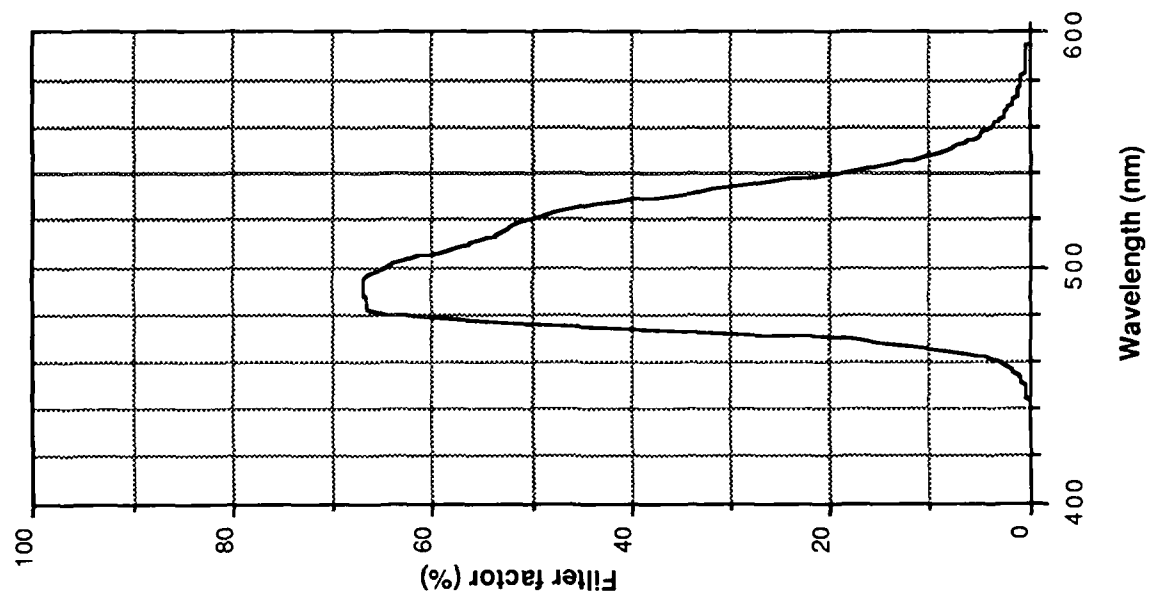


Figure 8

Combined LED &
Filter



Blue Filter 103187



SIEMENS Blue LED
Lamp

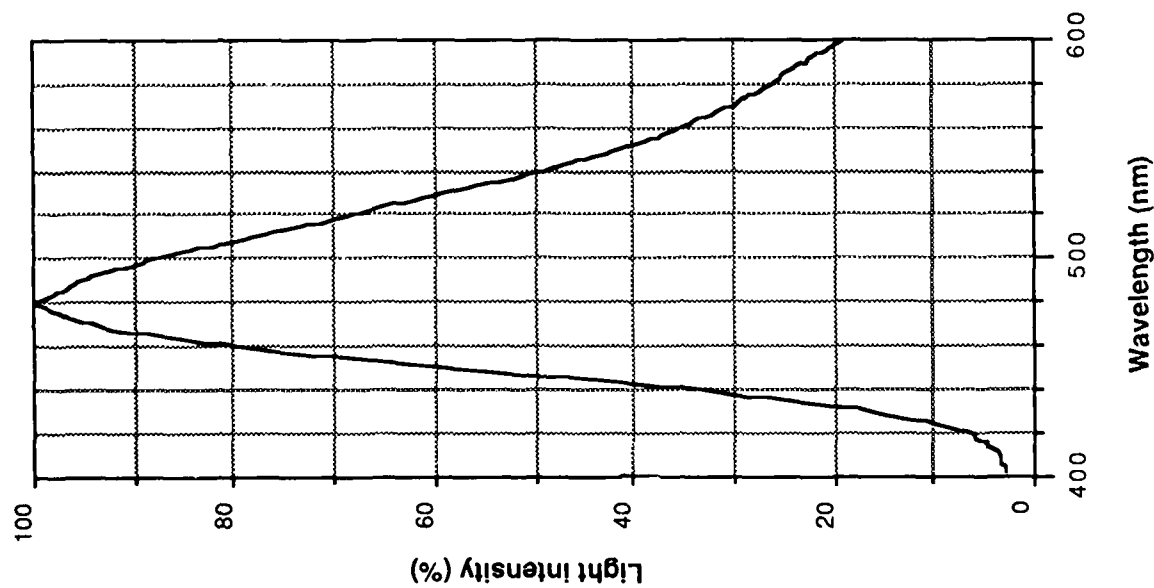


Figure 9

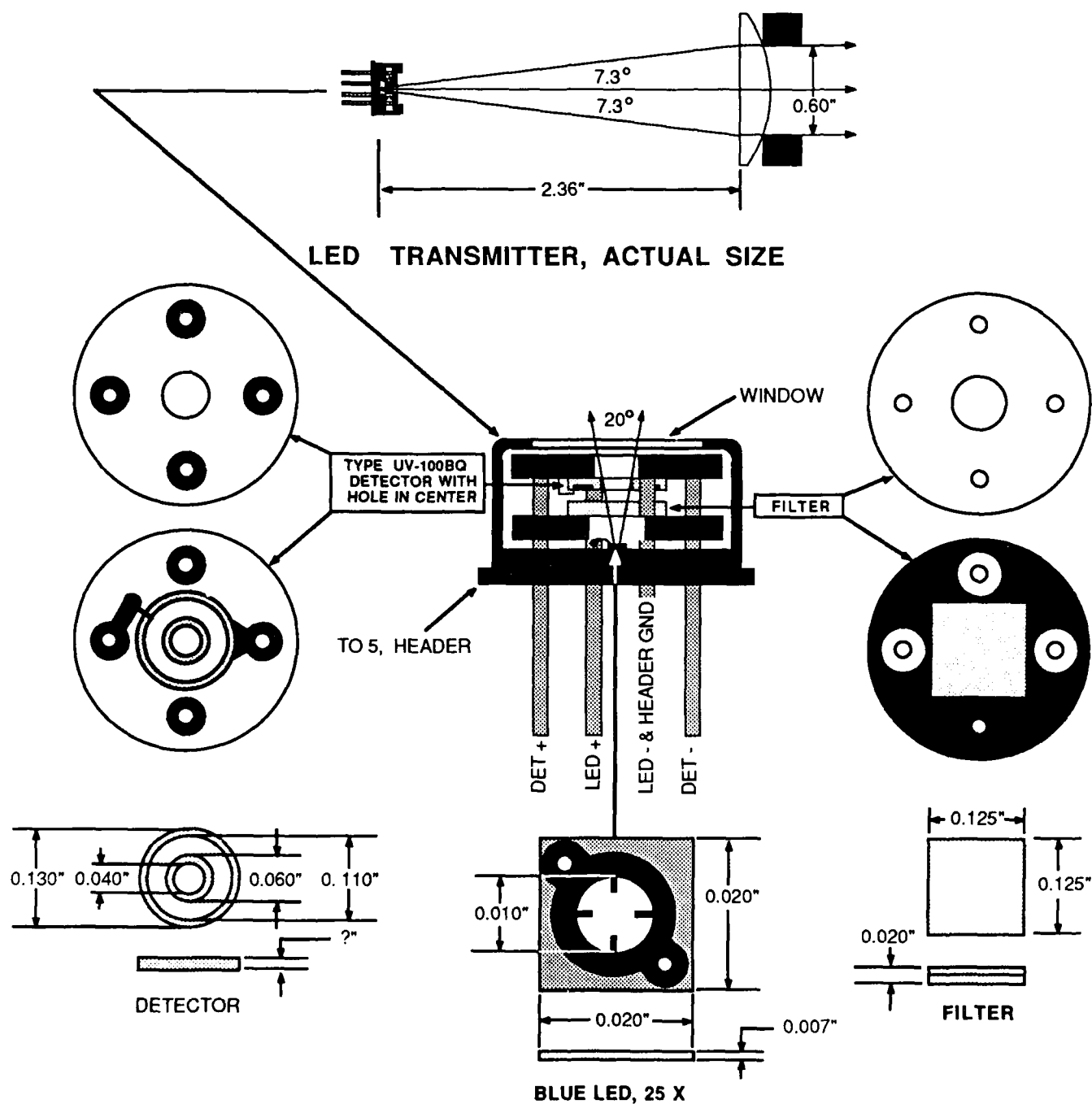


Figure 10, Light Source Design, Scale = 5 X



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FINAL REPORT CERTIFICATION

December 15, 1987

In accordance with item 5 on page 5 of contract number N00014-86-C-0784, Sea Tech, Inc. hereby certifies that the number of hours for which reimbursement has been obtained are as follows:

Direct Labor	Hours
R. Spinrad (P.I.)	332
R. Bartz (P.I.)	360
M. Rowland (Machinist)	233
D. Hyde (Secretary)	210

Sincerely

Robert Bartz
President

END

DATE

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